Fermilab Experience

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Introduction

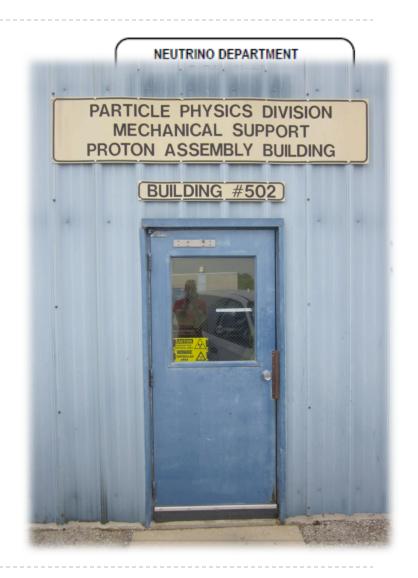
▶ The goals of Fermilab's TRAC program:

- To provide outstanding science, mathematics, computer science, and technology teachers with professional scientific, engineering, or technical experiences through summer research opportunities.
- Increased awareness and understanding of cutting-edge science and technology obtained by the teacher can be transferred back to the classroom.

My Assignment

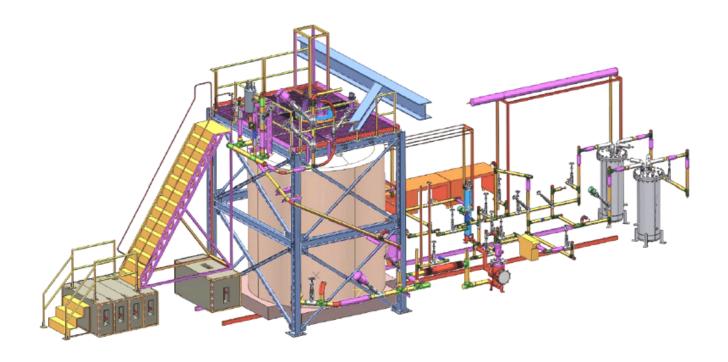
- Particle Physics Division
 - Neutrino Department





Liquid Argon R&D

- What is being developed?
 - Liquid Argon Purity Demonstrator (LAPD)
 - Liquid Argon purity must be demonstrated before neutrino research begins



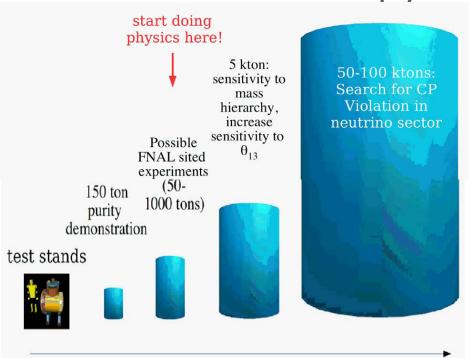
Liquid Argon Purity Demonstrator

Goals of LAPD

The primary goal of the LAPD is to test if required electron drift-lifetimes for a Time Projection Camber (TPC) can be achieved without evacuation in an empty

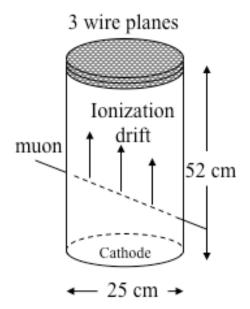
vessel

 An additional goal of LAl the cryogenics system to



Liquid Argon Purity Demonstrator

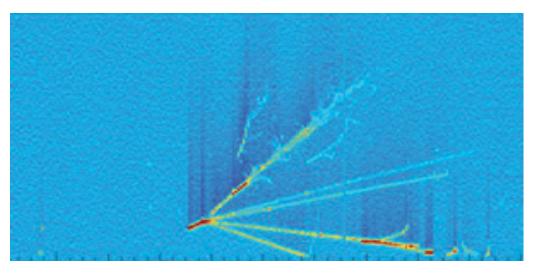
- Achieving Purity allows electrons to drift!
 - Purity is defined as:
 - ▶ 30 ppt equivalent oxygen contamination
 - Why do we need this degree of purity?
 - Other molecules such as 0² & H²O
 interfere with drift
 - Without purity no neutrinos can be detected



Liquid Argon Purity Demonstrator

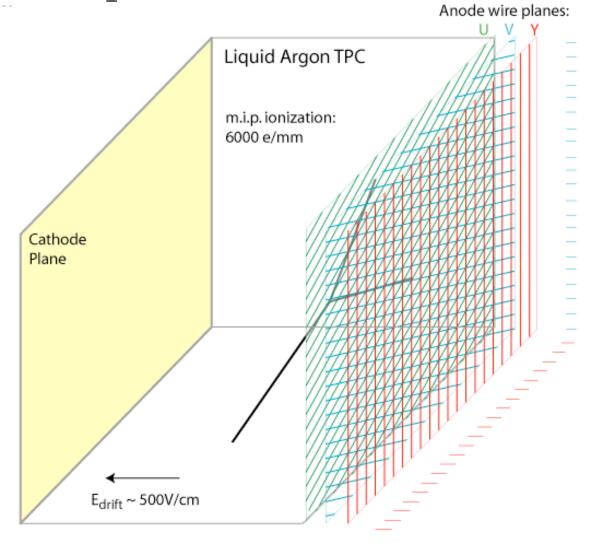
If the correct level of purity exists this is what you should

see:



- The observed tracks are a result of neutrinos indirect interactions with liquid argon electrons
 - Length, spin, & intensity all guide scientists to different particles

LAr TPC Operation



My Contributions

▶ Three Primary Roles

- Cryogenic Temperature Expansion Testing
- Trigger Counter Characterization
- Cryogenic Temperature Resistor Testing

Secondary Role

Student of all things Fermilab



- Identify an Epoxy which could withstand liquid nitrogen/ argon temperatures and not be compromised
 - Early testing revealed cracks in the epoxy which held copper wire to various components



- ▶ This work included:
 - Wrapping the g-10 board in wire





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- Mixing and applying several different epoxies to the g-10 board





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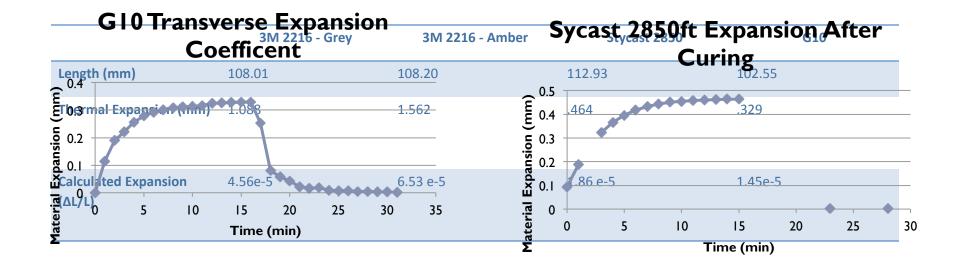
- Wrapping the g-10 board in wire
- Mixing and applying several different epoxies to the g-10 board
- Testing the thermal expansion of epoxy samples





Results

- Stycast 2850 closely aligns with thermal expansion of G-10
- Additional cryogenic epoxies have been recommend for further study



Trigger Counter Characterization

- Get rid of any light leaks which lead to interference with main signal, catalog characteristics, and label counters
 - ▶ This requires a great deal of electrical tape and patience
 - ▶ Each counter takes at least 3 hours to produce a complete signal



Trigger Counter Characterization

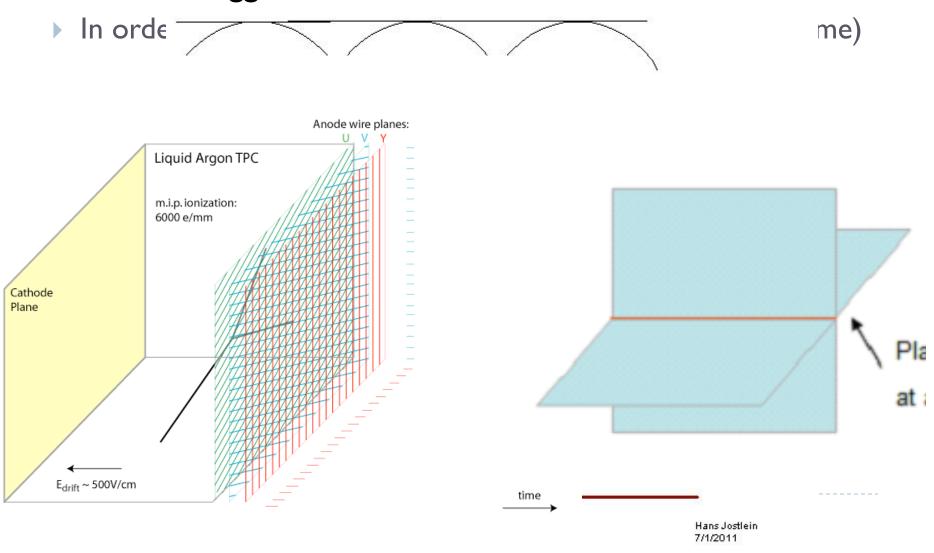
- Learning the complexities of the oscilloscope
 - ▶ 18 trigger counters were processed



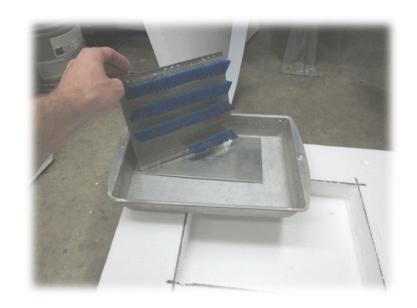


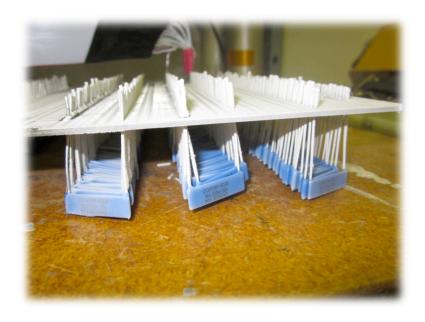
Trigger Counter Characterization

What are trigger counters used for?



- Measure the change in resistance when introduced into a cryogenic environment
 - > 240 Resistors where soldered onto a semi-conductive platform



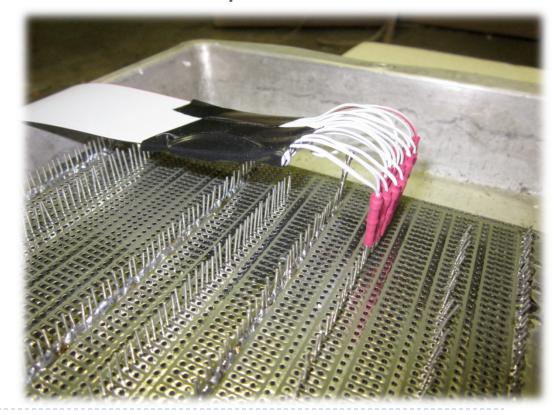


▶ Each resistor was measured to ensure acceptable changes in resistance and component resilience

Wire harnesses were created in order to provide a reasonable

testing format





Preliminary Results

Resistor	Room Temperature	Liquid Nitrogen - Trail 1	Room Temperature2	Liquid Nitrogen - Trail 2	Room Temperature3
1	101.4	107.69	101.34	107.68	100.36
2	100.29	106.72	99.37	105.68	99.49
3	102.5	108.51	101.68	107.48	101.56
4	98.13	105.62	97.24	103.59	97.22
5	101.5	107.82	100.43	106.8	100.4
6	99.16	105.42	98.85	104.97	98.28
7	100.3	106.4	99.39	105.47	101.67
8	98.8	104.75	97.88	103.81	97.83
9	101.85	107.89	100.86	106.91	100.79
10	103.23	109.48	102.61	108.51	102.22
11	103.43	109.84	102.43	108.84	102.42
12	98.33	104.05	97.44	103.27	97.43
13	98.4	104.91	97.57	103.45	97.53
14	99.62	105.59	98.65	104.74	98.63
15	103.12	109.24	102.16	108.29	102.41
16	98.53	104.61	97.66	103.81	97.64
wg.	100.54	106.78	99.72	105.83	99.74
tandard Deviation	1.91	1.89	1.93	1.97	1.96
⁄lin	98.13	104.05	97.24	103.27	97.22
Мах	103.43	109.84	102.61	108.84	102.42
*	* Measured in GOHM	15 min soak	1 hour warm-up	30 min soak	30 min warm up



Program Take Away

- I can share with my students the excitement that comes from scientific research
- I will strive to model curriculum in a way that accurately reflects the process of scientific innovation as observed at Fermilab
- I am now familiar with cutting-edge technologies and scientific endeavors
- I have made connections within my community that will allow my students to see what pursuing a career in science and technology could look like
- I have been affirmed in my calling to be a professional educator

Thank You

- ▶ Harry Cheung & Bjoern Penning Program Coordinators
- Stephen Pordes & Hans Jostlein Immediate Supervisors
- ▶ The amazing technicians, engineers, and physicists at PAB
- The staff at lab 6



And to the Jefferson community for supporting me on my journey



Neutrino?

ELECTRON-NEUTRINO

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The ELECTRON-NEUTRINO wears a

bandit's mask because he likes to steal away energy and is notoriously difficult to detect. Traveling close to the speed of light, he is the most pervasive form of matter in the universe Trillions of neutrinos are passing through everything around us, including us, at every moment. The result of radioactive neutron decay, most neutrinos originate from the sun. Their mass is next to nothing.

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- Neutrino Video
- http://www.youtube.com/watch?v=eLowijGc8Mg